Geol. Mag. **154** (3), 2017, pp. 419–440. © Cambridge University Press 2016
10.101 / 0016 56 16000042

‡, ‡†, ‡
& ‡
, 10003 ,
‡ 210016,
, 36 4 -5305,

(*Received* 1 2015; *accepted* 2016; *first published online* 1 2016)

Ab ac
( )
~4 5
~400
ε (*t*) (13 20) δ[1] (+5.3 ‰)

1. I c

(*et al.* 200 & , 200 *et al.* 2012 *et al.* 2012, 2013 *et al.* 2013),

(, 1 *et al.* 200 *et al.* 200 a).

(, 1 , 1 , 1 3 *et al.* 2000 & , 2003 *et al.* 200 , 2014). & (2011)

( ), (2014)

( ),

(ö, & , 1 3 , & , 2000 *et al.* 2002 *et al.* 2004, 200 a) (. 1).

(*et al.* 200 a,b , & , 2012).

(, 1 3 *et al.* 2003 *et al.* 2003 *et al.* 200 a) (. 1).

† 1 6

1. ( ) ( ) ( ) et al. 200).

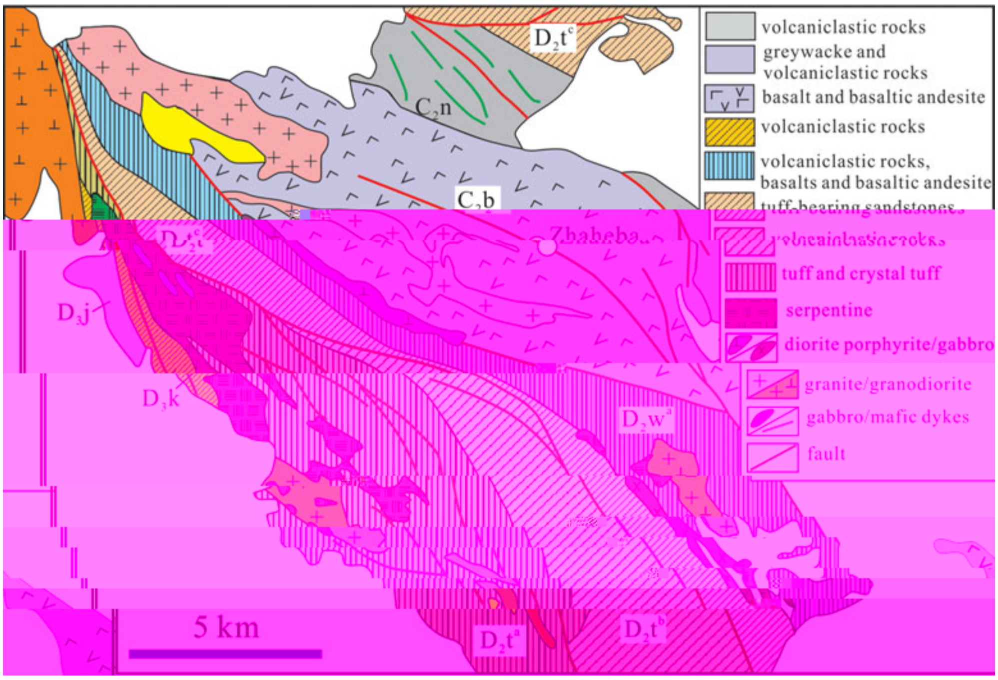
> 0 % , (. 3 ,). et al. 2013). (40 0 %) (30 50 %) (5 10 %) (. 3).

(1) (2)

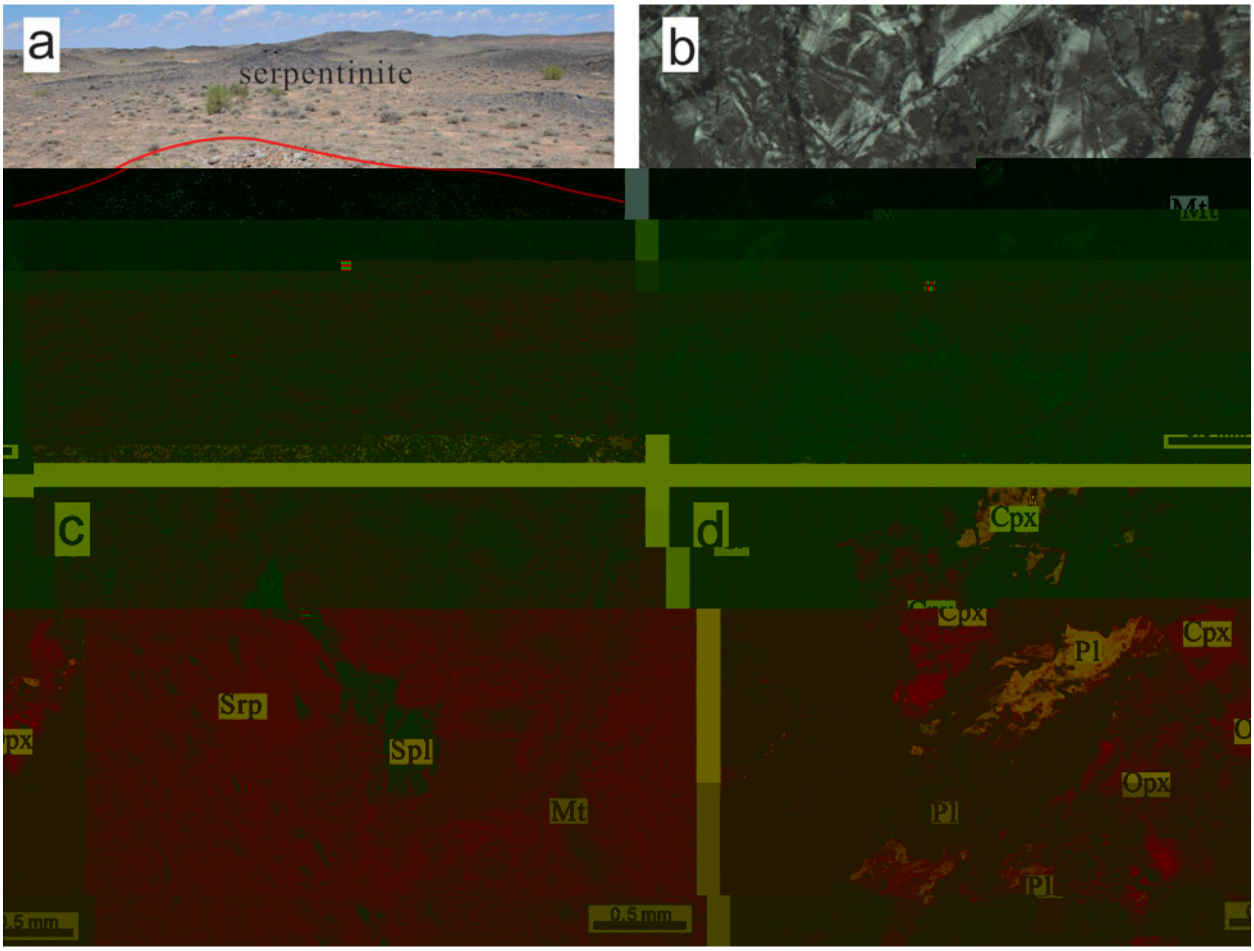
2. R a , b a a

(1 , 2). (. 3). 15 (. 2,). 1 5 1

( ) ( ) ( ) (et al. 2006). (. 2). (, 1 3).



[illegible] 2. ([illegible]) [illegible] ([illegible] *et al.* 200[illegible], 200[illegible] *a* [illegible], 1[illegible] 3).



[illegible] 3. ([illegible]) [illegible]

3. A a ca c

3.a. Z c U Pb a a H O a a

(2013 01, 46° 32′ 51 , ° 2′ 4) (2013 02, 46° 33′ 2 , ° 2′ 36)

( )

(- , -)

et al. (2011).

(et al. 2010) (, 2003).

5 %

1

2,

//. / .

12 0

et al. (2010a). ^{1} /^{16}

(, ^{1} /^{16} = 0.0020052),

( ) δ^{1} 5.31 ‰ (et al. 2010b).

δ^{1} 5.44 ± 0.21 ‰ (2), 5.4 ± 0.2 ‰ (et al. 2013).

3

//. / .

3.b. M a a a

00

15 15

20

4 5

//. / .

3.c. W - c a a

100

et al. (2004).

2 %.

6000

et al. (2004). 50

+ 3

-1, -2 -2,

-1 -

3,

3 5 %.

1.

+ 3

(- , -)

et al. (2004). / 6

143 /144 6 / =

0.11 4 146 /144 = 0. 21 ,

/ 6 0. 102

0. 0506 -1,

143 /144 0.512104

1 0.5126 1 -1.

2.

4. A a ca

4.a. Z c U Pb a

100 150 μ

1 1 2 1.

(. 4).

(22 123) (

5) / 0.4

0. 30

4 5. ± 2.5

1. [illegible]

[illegible]	2013 01-1	2013 01-3	20132 01-4	2013 01-5	2013 01-6	2013 01-	2013 01-	2013 01_1	2013 01_2	2013 01_4
					Major elements (%)					
[illegible]	3 . 0	4 .20	3 .41	3 .62	3 .22	3 . 2	3 .05	4 .22	46.4	51.2
[illegible]	0.05	0.20	0.05	0.05	0.04	0.05	0.04	0.14	0.12	0.2
[illegible]	0.61	1. 6	1.04	0.6	0. 0	0. 4	0. 0	1 .2	1 .64	1 .33
[illegible]	.44	4.6	.	.36	.5	.16	. 4	3.6	3.24	3.
[illegible]	0.0	0.10	0.11	0.11	0.11	0.0	0.11	0.0	0.0	0.0
[illegible]	3 .21	24.5	3 . 2	3 .	3 .0	3 .31	3 .44	10.04	.03	5.
[illegible]										

1.

	2013 01-1	2013 01-3	20132 01-4	2013 01-5	2013 01-6	2013 01-	2013 01-	2013 01_1	2013 01_2	2013 01_4
	0.005	0.064	0.00	0.005	0.00	0.003	0.003	0.051	0.044	0.222
	0.021	0.34	0.044	0.042	0.0 2	0.031	0.033	0.310	0.25	1.450
	0.004	0.04	0.00	0.00	0.011	0.005	0.005	0.04	0.043	0.21
	0.011	0.232	0.036	0.044	0.012	0.034	0.00	0.123	0.0 0	0. 3
	0.0 0	0.036	0.03	0.03	0.06	0.026	0.025	0.046	0.031	0.06
	0.26	1. 10	6.600	1. 0	0. 3	0.233	1.150	1.5 0	0.516	0.1 5
	0.406	0.0 2	0.12	0.112	0.0	0.1	0.054	0.16	0.1 1	0.6 5
	0.046	0.034	0.014	0.02	0.050	0.030	0.010	0.050	0.02	0.130
	0.1 1	0.144	0.203	0.364	0.042	0.0 4	0.0	0.066	0.042	0.0 3
	2013 01_5	2013 01_6	2013 01_ (1)	2013 01_ (1)	2013 01_ (1)	2013 03_2 (1)	2013 03_3 (1)	2013 03_4 (1)	2013 03_5 (1)	2013 01_3 (2)
					Major elements (%)					
2	4 .1	45.	4	53.1	51. 1	50.40	50.54	50.52	51.22	52.3
2	0.34	0.15	1.40	1.24	1.31	1. 0	1.63	1.31	1.1	0.33
2 3	1	1 .5	16.5	16.1	15. 3	15.	16. 6	15.55	15.4	1 .61
2 3	4.52	3.34	.	.11	.43	.0	.50	.42	. 2	3.44
	0.0	0.0	0.11	0.10	0.11	0.13	0.11	0.14	0.12	0.0
	6.	.42	4. 0	4.2	4.41	5.	3.2	6.06	.14	4.
	11.03	12.61	6.22	5. 5	6.3	6. 5	4.52	.4	.26	. 0
2	4. 6	.3	. 2	.3	.00	4.52	.31	4. 0	4.0	.11
2	0.13	0.11	0.3	0.31	0.42	2.04	0.33	1.2	2.03	0.1
2 5	0.04	0.02	0.62	0.62	0.65	0. 4	0.6	0.4	0.44	0.04
	3. 2	3.26	4.24	2.54	2. 3	2.2	5.14	2.65	1. 3	2.
	. 5	. 2	. 6	. 0	.4	.40	. 1	.6	.6	. 1
	4.	.4	.11	. 0	.42	6.56	.64	6.0	6.11	.2
#	5	1	55	54	54	56	41	56	64	4
					Trace elements (ppm)					
	.0	4. 5	1.16	1.12	1.4	.0	40.4	5.2	6. 2	5. 1
	0.22	0.135	1.2 4	1.6 3	1.316	1. 53	1.034	1.100	0.5 5	0.62
	25.0	23.	1 .6	1 .5	1 .5	.5	1 .2	25.2	1 .	1 .0
	11	3.	1 6	166	1 2	22	22	254	1	5.
	34.	163	60.5	62.6	64.1	116	1 .	. 0.	203	23.
	24.2	21.6	26.	23.6	24.6	2 .	2 .5	2 .0	2 .0	16.4
	4.	1 5	63.6	50.	51.4	6.	2 .	5 .3	132	1.1
	52. 4	55.5	.1 . (23. 1 5.3(21.6)- .2(0.3.)-6	6240.434.2(254)-641221.1( ) 2 - .46 2 0 30 . 5	6.(6.22)-6240 2. (15.55)-5 5.4(2. 4)-56	. (1 36(01_-1.0556( ) 5.3(2)				

1.

	2013 01_5	2013 01_6	2013 01_	2013 01_	2013 01_	2013 03_2	2013 03_3	2013 03_4	2013 03_5	2013 01_3
y			(1)	(1)	(1)	(1)	(1)	(1)	(1)	(2)
	3.	1.20	3 .60	46. 0	4 .30	23.40	43.00	25.20	32. 0	6.56
	. .	2.6	.50	.1(15101..6(. 0)-5 46.414 .30)-5 4 . 3 . 0						

-5046.001. 0

1.

	2013 01_11 (2)	2013 02_1 (2)	2013 02_2 (2)	2013 03_1 (1)	2013 03_6 (1)	2013 01_10 (2)	04 06 (1)	04 24 (1)	04 2 (1)	03 1 (1)
				Trace elements (ppm)						
	1 .4	36.	42.4	26.0	32.4	1 .	/	/	/	/
	0.3 5	0.153	0.35	1.1	0. 4	0.46	/	/	/	/
	32.5	33.2	34.5	25.1	26.3	32.1	13.4	20.5	1 .	20.3
	1 4	203	21	33	341	1 5	144	1 4	214	265
	56.5	44.2	4 .	1 .	22.2	53.	15	162	214	265
	34.	3 .5	3 .3	23.1	24.	33.	20.6	30.	2 .	20.2
	66.4	4.6	6.4	25.4	2 .1	66.6	.1	114	5.5	.02
	6.4	236.4	256.	205.4	20 .	114.20	/	/	/	/
	4 .0	44.1	4 .0	4.	103	44.1	/	/	/	/
	12.0	11.1	11.2	14.	13.6	12.0	/	/	/	/
	0.5	1.420	1.0 0	3.130	3.2 0	0.5 3	4.	1 .1	22.0	1 .2
	1	1 50	5	2 0	24	6 6	1	31	111	6
	13.0	13.0	13.2	21.1	22.	12.5	13.2	13.2	14.	20.1
	54.	42.3	41.5	144	154	52.	243	133	164	151
	1.2	0. 4	0. 55	11.315	11. 5	1.25	20.2	12.	21.	12.2
	0.025	0.030	0.02	0.051	0.052	0.02	/	/	/	/
	0.3 1	0.2 6	0.32	1.560	1.450	0.360	/	/	/	/
	0.2	1. 20	1.030	0.365	0.406	0.336	/	/	/	/
	11	3 2	346	25	50	4.3	/	/	/	/
	10. 0	. 40	.610	26.40	26. 0	10.50	30.6	32.2	40.1	26.4
	23.00	1 . 0	1 .40	51.50	54. 0	22.30	5 .	62.	2.3	52.5
	2. 0	2.520	2.510	5. 50	6.1 0	2.6 0	6.	. 4	10.5	6.4
	11. 0	11. 0	11.60	22.30	24.30	11.60	2 .5	31.2	43.1	24.4
	2.540	2. 00	2.6 0	4.4 0	4. 00	2.3 0	4.5	5.2	6.	4. 5
	0. 6	0. 1	0. 0	1.163	1.25	0. 3	1.45	1.5	2.0	1.03
	2.4 0	2. 13	2. 54	4.14	4.46	2.522	3.56	4.01	5.35	4.23
	0.3 6	0.3	0.3	0.612	0.660	0.3 4	0.4	0.54	0.64	0.63
Y	2.1 0	2.150	2.220	3.420	3.6 0	2.130	2.5	2.	3.24	3. 5
	0.46	0.446	0.444	0. 2	0. 5	0.46	0.4	0.52	0.5	0.
	1.350	1.230	1.240	2.120	2.2 0	1.310	1.32	1.3	1.45	2.25
	0.1 0	0.16	0.1 5	0.304	0.32	0.1 4	0.1	0.2	0.2	0.34
	1.210	1.050	1.120	1. 60	2.110	1.210	1.25	1.23	1.24	2.13
	0.1 4	0.164	0.165	0.2 1	0.323	0.1 3	0.20	0.1	0.1	0.34
	1.3 0	0. 41	1.040	3.2 0	3.510	1.460	5.3	3.2	4.16	3. 2
	0.0 4	0.062	0.051	0.5	0.644	0.0	1.35	0.6	1.16	0.6
	0.151	2.0	1.50	2. 5	1.	0.33	/	/	/	/
	0.3 4	0.206	0.200	45.20	35.10	0.41	.13	.0	4.1	21.06
	1. 0	0. 61	0. 1	. 60	.2 0	1. 0	4.50	2.63	3.20	.41
	0.500	0.304	0.302	2. 30	3.4 0	0.501	1.	0.6	1.46	2.5

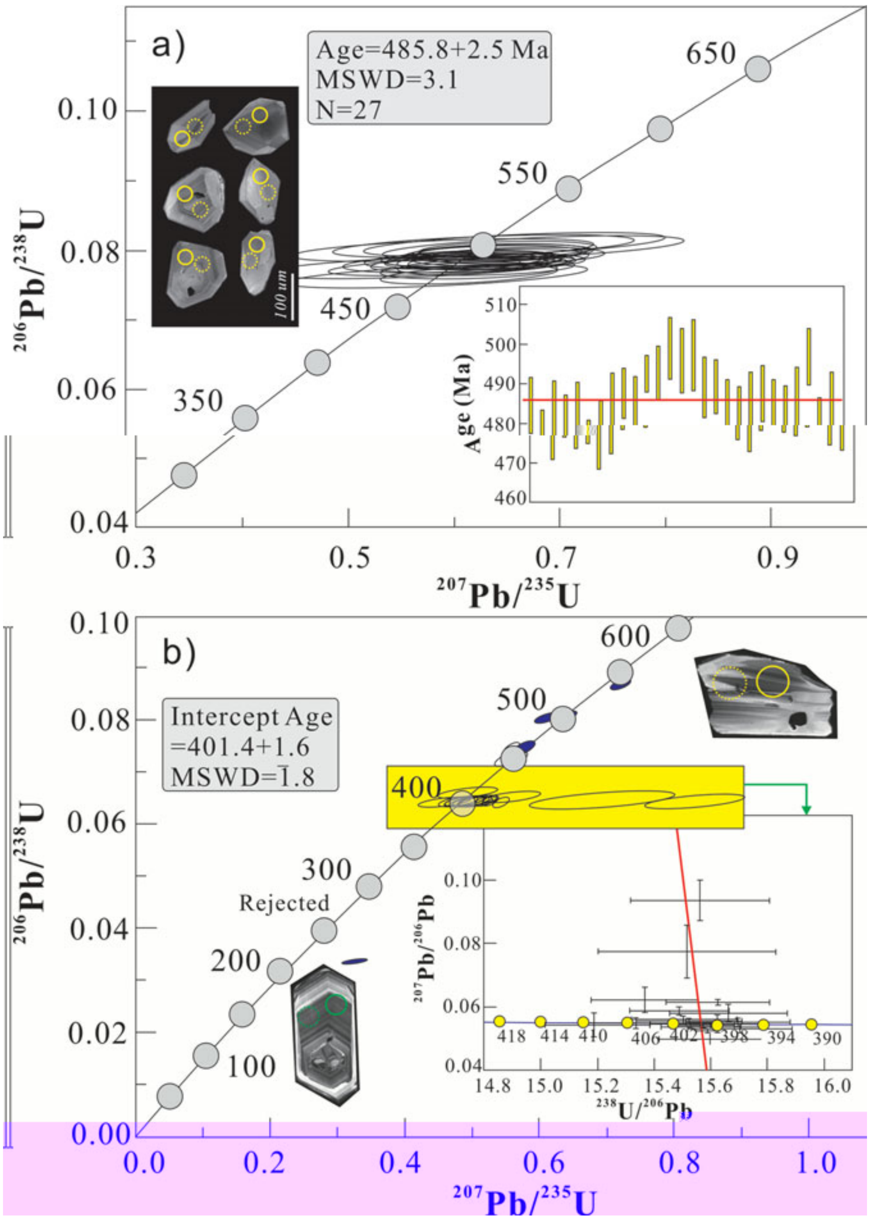
/

04 06, 04 26, 04 2 , 04 1 *et al.* (200 *a*).

2.

	y	( )	( )	^{6} /	^{6} / (1σ)	(^{6} /)	( )	( )	^{14} / ^{144}	^{143} / ^{144} (1σ)	(^{143} / ^{144})	ε (*t*)
2013 01_3	(2)	0.36	3 2	0.002	0. 04030(2)	0. 04015	2.4	10.	0.13 4	0.512 3 (40)	0.5124 4	6.
2013 01_10	(2)	0.5	6 6	0.0024	0. 04 5 (23)	0. 04 45	2.3	11.6	0.1235	0.512 0 (43)	0.5124 6	.1
2013 03_1	(1)	3.13	2 0	0.0335	0. 06324(20)	0. 06133	4.4	22.3	0.121	0.512533(4)	0.512214	1.
2013 03_2	(1)	2.	1320	0.0063	0. 042 (20)	0. 04255	4. 5	2 .6	0.1046	0.512 1 (51)	0.512445	6.3
2013 03_3	(1)	.06	516	0.0452	0. 0536 (43)	0. 05111	5.	36.	0.0	0.512 0 (30)	0.512450	6.4
2013 03_4	(1)	.65	14 0	0.01	0. 0422 (51)	0. 04120	4.55	24.5	0.1123	0.512 03(53)	0.51250	.5

ε (*t*) = 10 000((^{143} /^{144}) (*t*)/(^{143} /^{144}) (*t*) − 1) ε (*t*) (/ ^{6}) 401. .



4. ( ) 1σ y 2σ ( ).

(. 4 = 2 , = 3.1). - / 1 3. - y 4 ± 4. . — , y 1 (1) , 0% (*et al.* 2003). , y y , - y - , 100 200 µ . (2)

(2, . 4).

2

450

500

21 1

206 23

401 ± 2 (= 3.3).

206 23 20 235

401.4 ± 1.6 (= 1.) (206

. 4),

23

(, 1 3).

4.b. M a c

4.b.1. Spinel composition

(. 3). 100 300 μ

4 // /).

2 3, 2 3

2

. (100 /(+))

44 60 . (100 /(+))

25 61.

(et al. 2010).

( )

(et al. 2013).

4.b.2. Pyroxene compositions

(= 4 6).

2

(0.5 %)

5 //

/).

41 4 , 46 55 1

(. 5).

2 3, 2 2

(. 5 ,).

4.c. W c a c

4.c.1. Serpentinites and cumulates

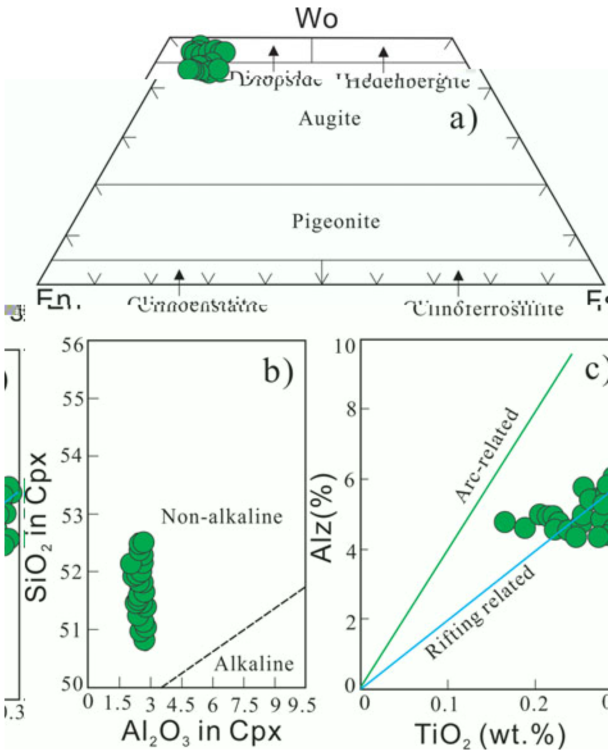
( )

(> 12 %,

) 2 (40 %), 2 3 (

1.0 %), 2 (0.03 0.06 %), 2 (0.04

0. 2 %) 2 (0.04 0.05 %). 2 3



5. ( ) ( )

. ( ) 2 (%) . 2 3 (%) ( )

( ) 2 (%)

1 (1).

(. 6).

(3 103)

(5) (1). (> 12 %)

2 , 2

(,)

( ) (. . ,

).

2 3, 2 3 2,

( )

( ) (1).

( ),

(, 2014

&

, 1).

2

45. % 51.2 %,

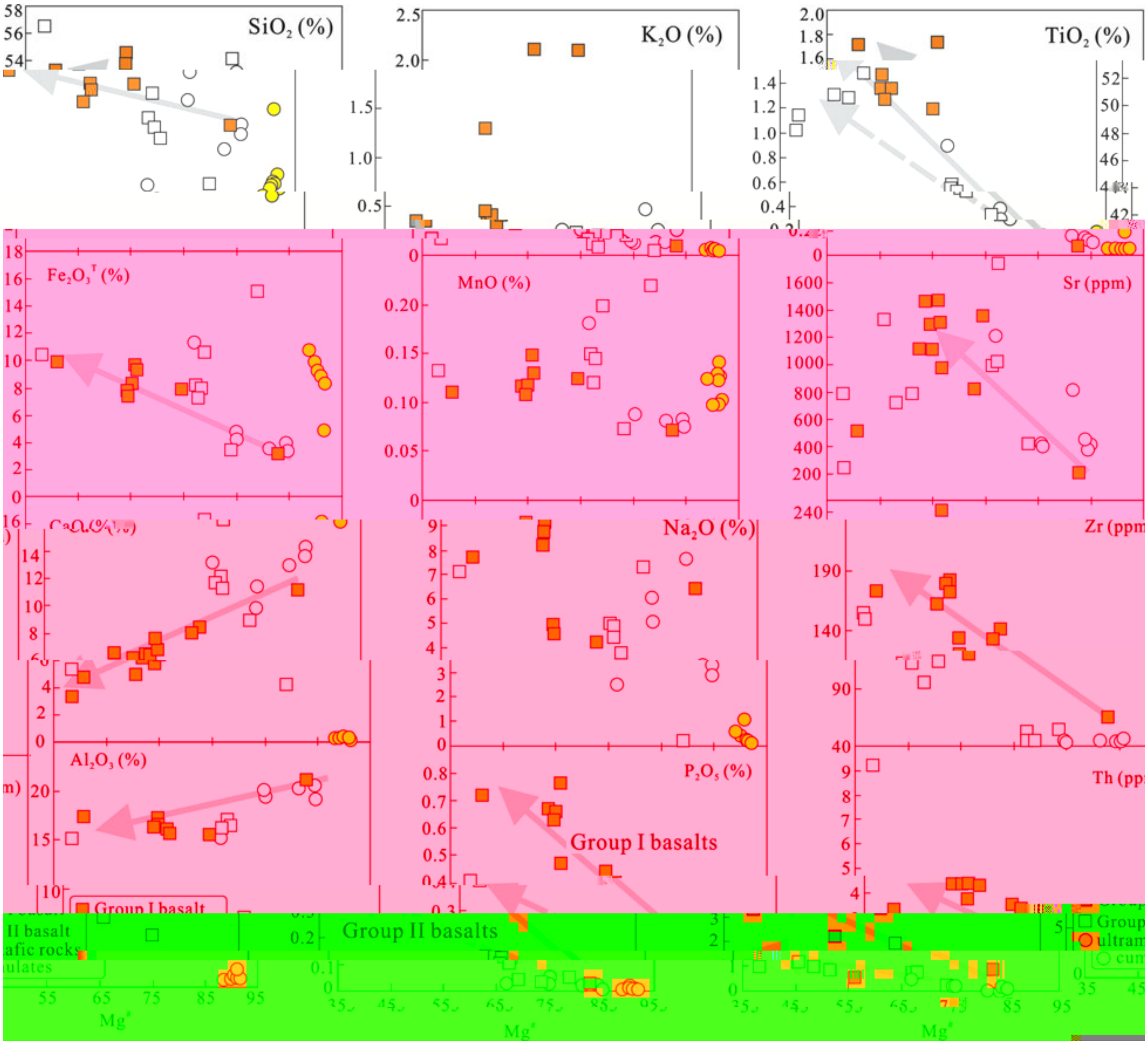
2 3 (3.24 4.6 %), 2 3 (1 .3 1 .6 %,

2013 01-3), (.54 15.42 %), 2

(0.12 0.34 %), 2 (2. 1 .3 %,

2013 01-3) 2 (0.11 0.46 %)

/ (1).



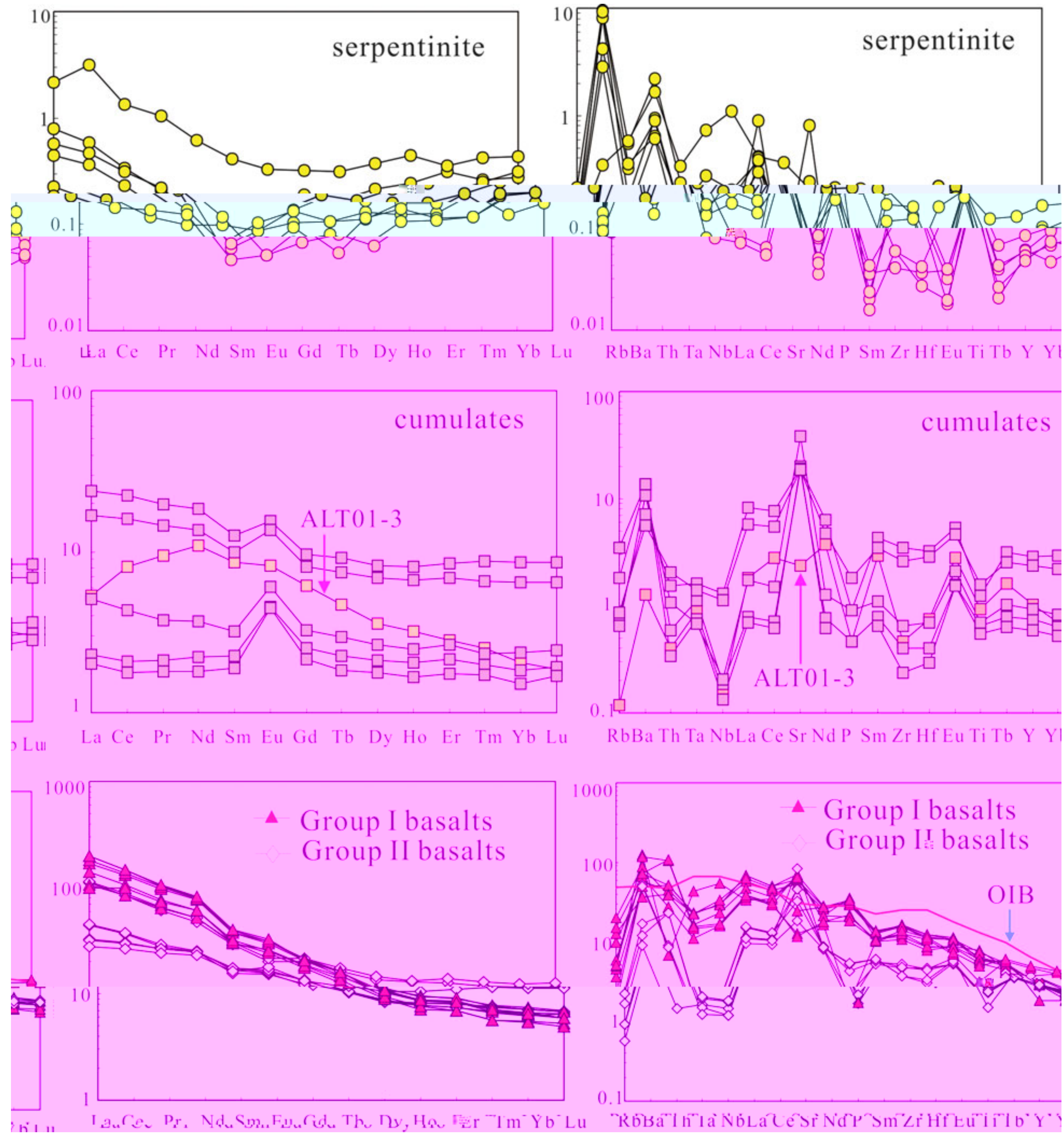
6. ( ) (2, 2 , 2 , 2, 2 3 , 2 3, , ,) (*et al.* 200 *a*).

(. 6). 5 41 ( ) ((/) = 1.3 2.) (/ = 1.1 2.2). 2013 01-3 ( ) (.), (/ = 0.2 0.4)

1). / . / 2, 1 (1) 2 (2). 2 (.). 1 2 / 2 (.). 2, 2 3 , 2 5, 2, 2 3 1 2 , 2 5, 2, . (. 6). 1 124 205 2 50 60 . 1 (/) 10 30 (20)

4.c.2. Basalts

2 43.15 % 5 .65 % (52 %,

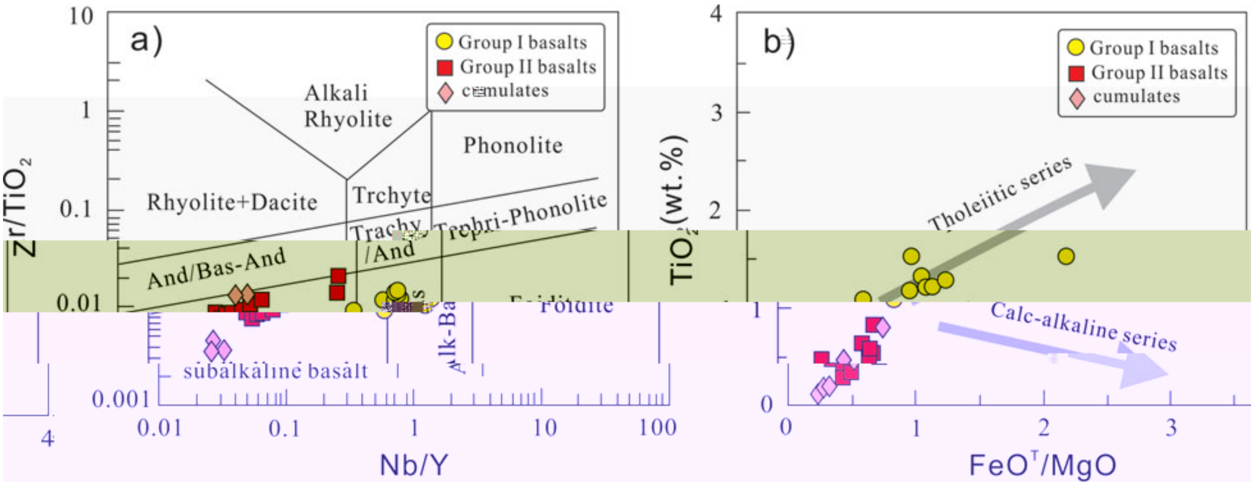


. ( ) &. (1).

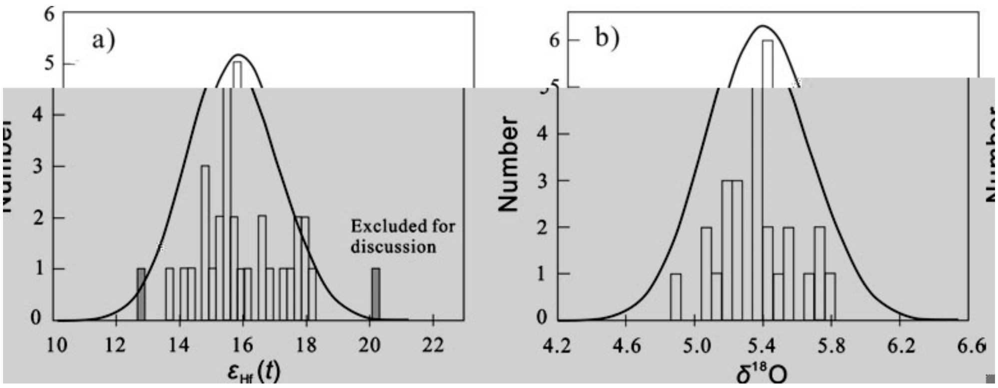
(/ = 0. 0 1.14) (.). 2 (/) 4 6 (/ = 1.02 1.21) (.). 1 0.44 0. , 2 1 (~0.11). (.).

4. . W - c S N a z c H O

2. 1 2 / 6 (0.0024 0.0452) / 6 (0. 04030 0. 0536), / 6 (0. 04015 0. 05111, 2013 03_1). 14 /144 0.0 0.13 4 143 /144 0.512 0 0.512 3. ε (*t*) +6.3 + .5 (2013 03_1 +1.).



. ( ) ( ) (/ 2 /) (& , 1). ( ) - 2 / - - (1 4).



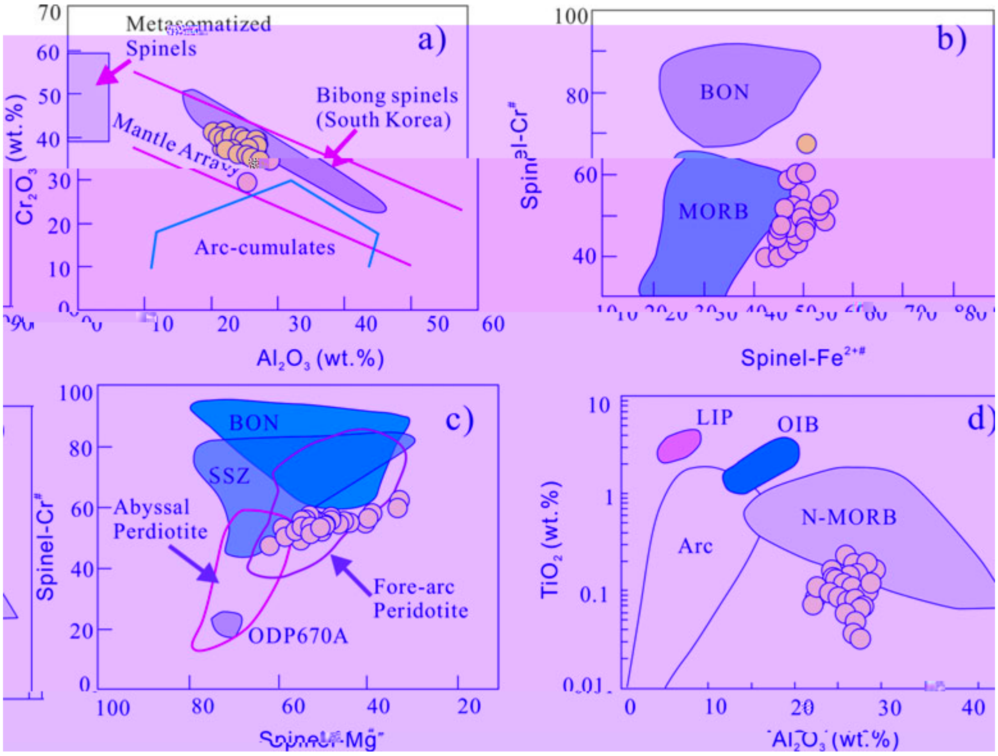
. ( ) ε (*t*) ( ).

(2013 01) (- 2 // /), ε (= 4 5.) 13 20. 2 5. 5 ε (*t*) (> 16) ε (*t*), 15. - δ1 4. 1 ‰ 5. 3 ‰, ( ). - δ1 5.3 ± 0.23 ‰ ( ). ~400. ε (*t*) 1.4 .2 - 6 0. 20. - (*et al.* 200).

5. D c

5.a. T a b Z a ba

- *c.* 4 6. 401. , (503 ±) - (416 ± 3.) (*et al.* 2012 *et al.* 200 b, 1). - (401.) (4 6.) (-) , - (, 1 3). (1), ,

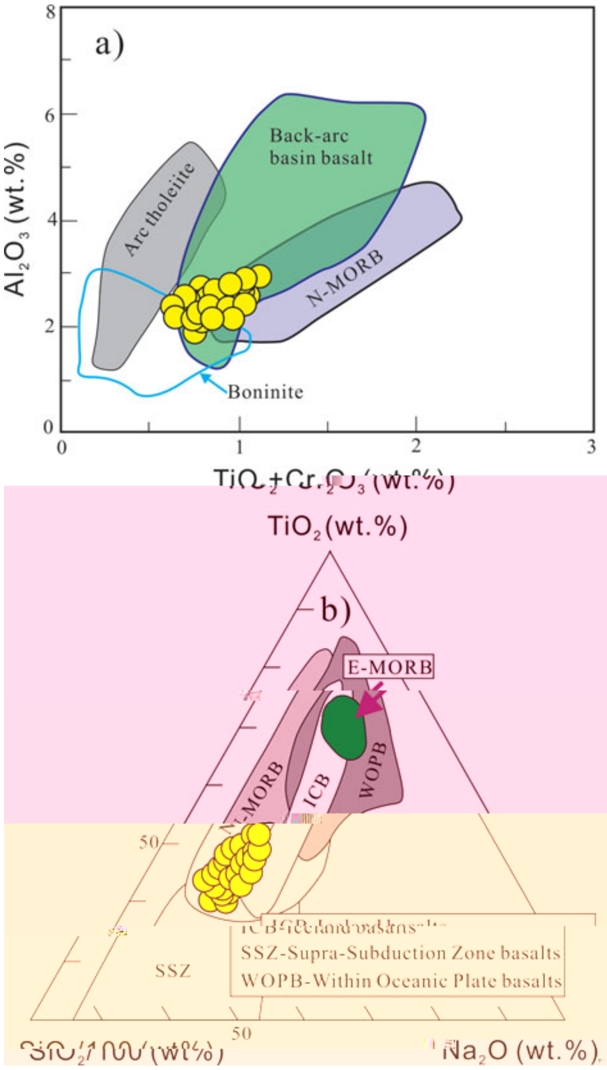


10. ( ), . ( ) $_{2}$ $_{3}$ $_{2}$ $_{3}$ (%) (& , 2000). ( ) . (100 /(+)) $^{2+}$. (100 $^{2+}$/($^{2+}$ +)). (, 1 4 & , 2001). ( ) . (100 /(+)) . (100 /(+)). (*et al.* 1 5). ( ) $_{2}$ $_{2}$ $_{3}$ (, & , 2001).

(500 4 0) (*et al.* 2003 *et al.* 2015), (430 400) (*et al.* 200 b, 2014) (3 0 350) (*et al.* 2003 *et al.* 2006).

5.b. O a c a

(, & , 2002 *et al.* 2010



11. ( ) ( ) 2 3 2 + 2 3 ( ) 2 2/100 2

(-y).

5 ,

2 3 2 + 2 3

(. 11). 2/100 2 2

(. 11).

(.).

(. 12),

(. 12).

et al. (2002)

( ).

5.c. P D a ba a

1

2. 1 (11 24 ,

15), 2 5 (0.4 0.6 %)

(11 15, 60) (/)

( ) (, & , 1 2 ,

& , 2001) (. 13).

(1)

(. . , &

, 2002) (2)

(, &

1 2 & , 1 3 *et al.* 1 6).

1

(, & , 200 *et al.*

2011). 1 / 6

(0. 04120 0. 06133) ε (*t*)

(+1. + .5).

/ (3.44 20.4)

/ (1.51 2.54) (.

& , 1 6).

1

(*et al.*

1 6 , 1 6).

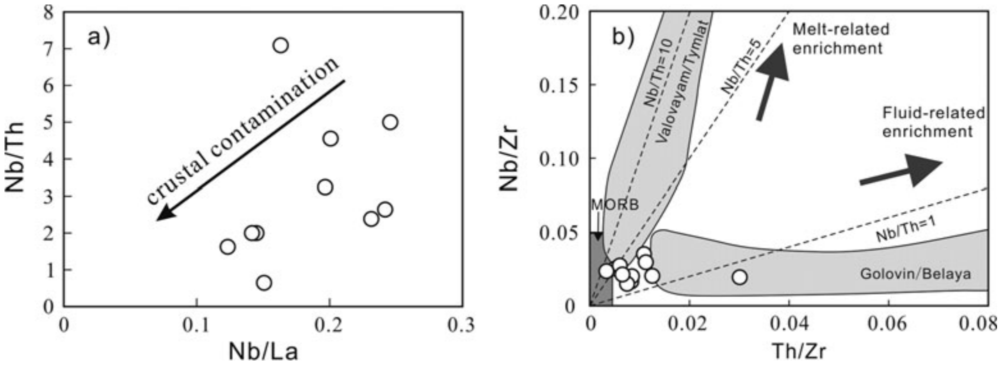
(& ,

2000).

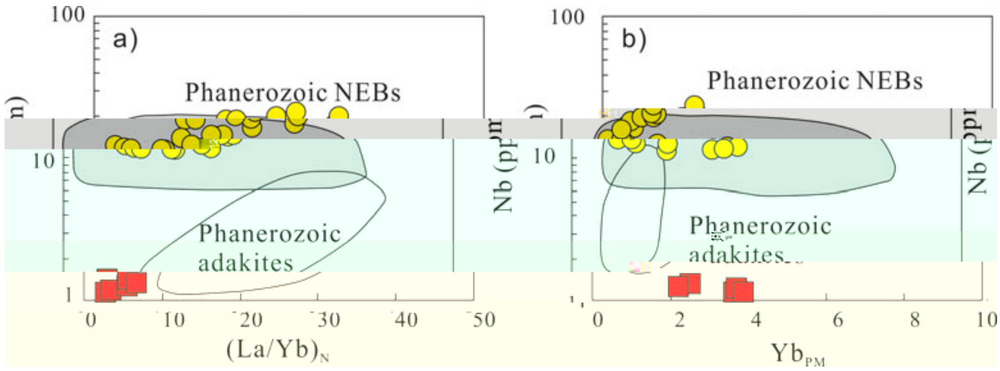
(

& , 1 2 *et al.* 1 6). *et al.*

(200)



12. ( ) / . / ( ) / . /



13. ( ) ( ) (/) ( ) 1 ( ).

1 ε (t) (1. .5) (/ [6]) (0. 04120 0. 06133) (2). ε (t) (/ [6]) 1

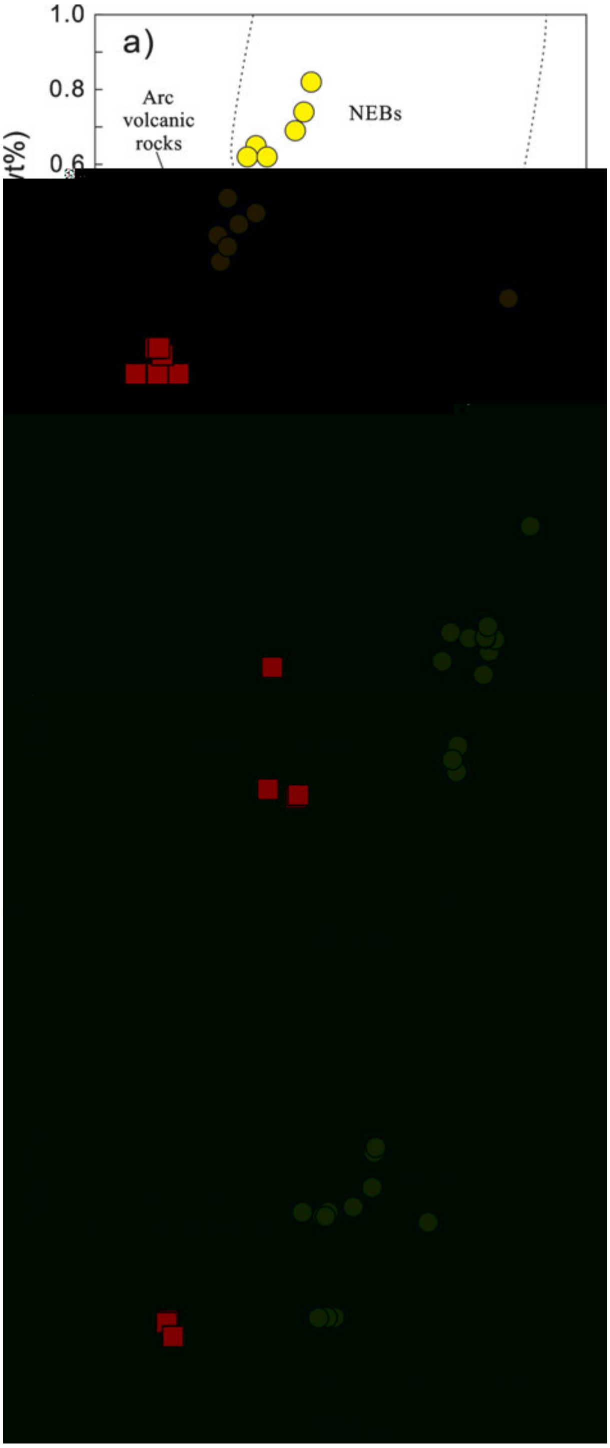
2 2, / (< 0.3), / / ( ), / (& , 1 1 , 2002).

2 (/) (0. 1.0), (/) (0.1 0.2) / (0.6 1.0) 2 (& , 1 6). 1 , 2 , [2] [5] / (/) (1 . 14).

(. 14). , 2 1 2

5. . I ca Pa a z c acc c a J a

(416. et al. 2014 et al. 2015), (503 4 5. et al. 2003 et al. 2015) (400.) (. 1). (et al. 2014), (et al. 200 , 200 a,b et al. 200 a)., (et al. 200 b).



14. ( ) ( ), 2 5 2 . ( ) ( ) ( ) ( ) & (1 2) *et al.* (1 5),

et al. (2015)

400 3 0.

460 3 5. *c.* 400. (*et al.* 2006, 200 *et al.* 200 *et al.* 200 *et al.* 200 , 200 *et al.* 2012 *et al.* 2015).

(& , 2002 *et al.* 200).

(*et al.* 2015).

(5.), 1 2

(1 , 15). *et al.* (200 , 200 *b*)

(*et al.* 200).

(, & , 1 1 , & , 200 *et al.* 2013).

(. 15).

(1) (*c.* 500),

(. 15).

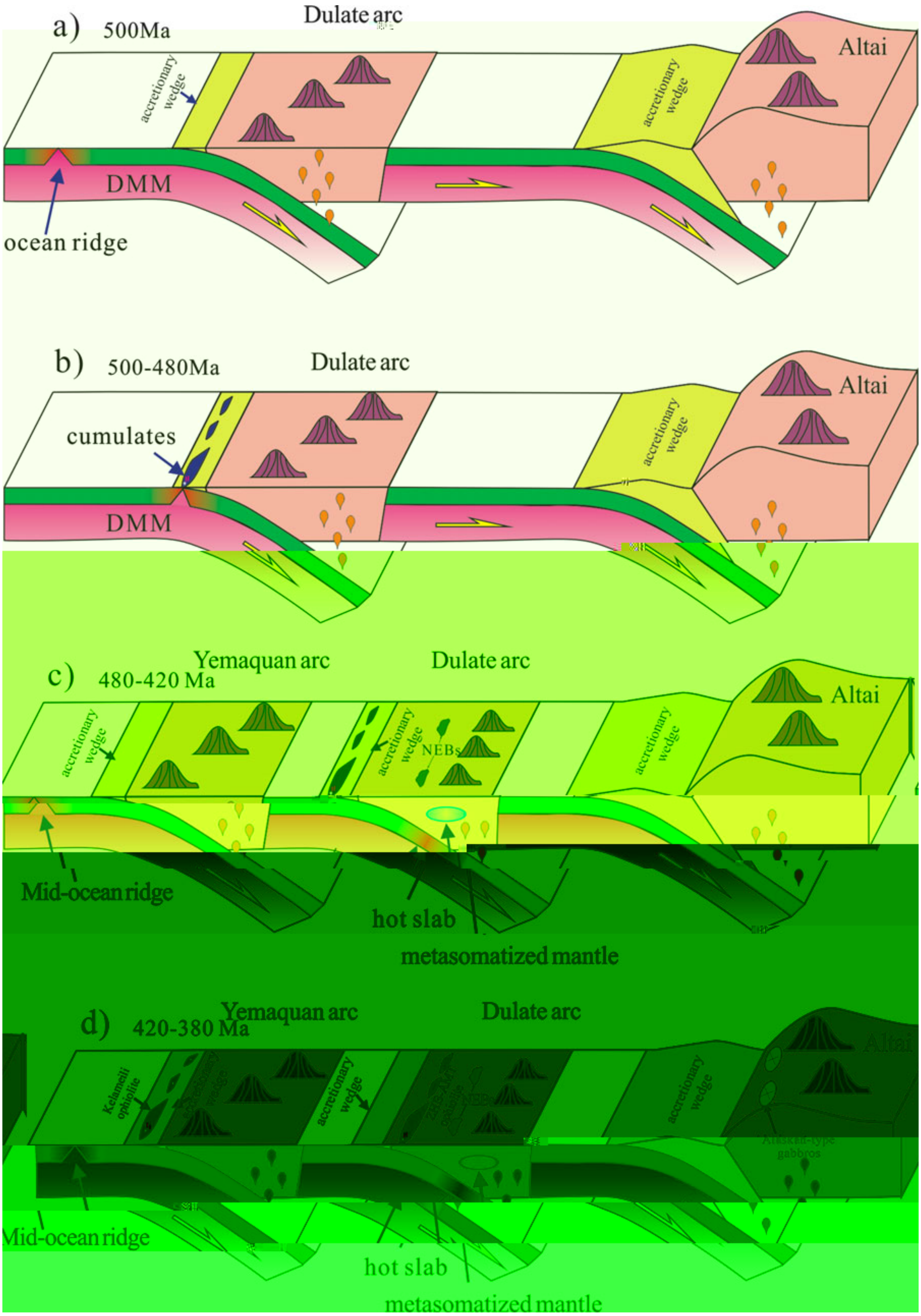
(2) (500 4 0.),

(. 15).

(3) (4 0 420), (45 *et al.* 2015)

(440 *et al.* 2014)

(. 15).


a) 500Ma
Dulate arc
accretionary wedge
Altai
DMM
ocean ridge
b) 500-480Ma
Dulate arc
cumulates
accretionary wedge
Altai
DMM
c) 480-420 Ma
Yemaquan arc
Dulate arc
accretionary wedge
NEBs
Altai
Mid-ocean ridge
hot slab
metasomatized mantle
d) 420-380 Ma
Yemaquan arc
Dulate arc
Kelameili ophiolite
accretionary wedge
Altai
Mid-ocean ridge
hot slab
metasomatized mantle

15. ([illegible]) [illegible]

(4) (420 3 0.)
(et al. 2014 et al. 2015).
1 ( ) 2
y (. 15).
(400 3 0.).

6. C c

(1) ~4 5. , c.
400.

(2)

(3)

Ac
305,
(2011 06 03-01).

S a a a

//. /10.101 / 0016 56 16000042.

R c

, . 1 4. . *Chemical Geology* **113**, 1 1 204.
, . . & , . 2001. *Journal of Petrology* **42**, 22 302.
. & . 200 . . *Lithos* **97**, 2 1 .
. & 2002. . *Geology* **30**, 0 10.
. & . 200 . *Earth Accretionary Systems in Space and Time* (&), . 1 36. . 31 .
. & . 2002. . *Geological Magazine* **139**, 1 13.
. 1 3. *Geological Society of America Bulletin* **105**, 15 3 .
, . . 1 . *Ophiolites*. , 220 .
. . & . 1 3. . *Geology* **21**, 54 50.
. & . 1 2. . *Journal of Geological Society, London* **149**, 56 .
. & . 1 4. . *Contributions to Mineralogy and Petrology* **86**, 54 6.
. & . 2003. (2) *Ophiolites in Earth History* (&), . 43 6 . 21 .
. & . 2011. . *Geological Society of America Bulletin* **123**, 3 411.
. & . 2015. . *Chinese Journal of Geology* **50**, 140 54 ( ).
. & . 2000. . *Contributions to Mineralogy and Petrology* **140**, 2 3 5.
. & . 1 1. . *Lithos* **27**, 25 .

& 2011. *Geological Bulletin of China* **30**, 150 13 ( ).

& 2011. ? *Geochimica et Cosmochimica Acta* **75**, 504 2.

& 2001. *Nature* **410**, 6 1.

& 2002. ( ) *Chemical Geology* **182**, 22 35.

& 1 6. *Journal of Geophysical Research: Solid Earth (1978–2012)* **101**, 11 31 .

& 2000. 2. *Contributions to Mineralogy and Petrology* **139**, 20 26.

& 2012. *Geological Bulletin of China* **31**, 126 ( ).

& 2014. ( ). *Chinese Science Bulletin (Chinese Version)* **59**, 2213 22.

& 2000. *Transactions of the Royal Society of Edinburgh: Earth Sciences* **91**, 1 1 3.

& 1 0. *Journal of Petrology* **31**, 6 1.

& 2003. *Earth Science Frontier* **10**, 43 56 ( ).

& 2001. *Journal of Petrology* **42**, 655 1.

1 6. *Nature* **380**, 23 40.

& 2000. *Tectonophysics* **326**, 255 6 .

& 2010*a*. 50. *Lithos* **114**, 1 15.

& 2004. *Geological Magazine* **141**, 225 31.

& 2010*b*. *Geostandards and Geoanalytical Research* **34**, 11 34.

& 2013. *Chinese Science Bulletin* **58**, 464 54.

& 200 . *Lithos* **113**, 2 4 1.

& 2010. *Chinese Science Bulletin* **55**, 1535 46.

2003. *User's Manual for Isoplot 3.00: A Geochronological Toolkit for Microsoft Excel.* 4, 3 .

& 2015. ( ) *Gondwana Research*, 6. 2015. 10.1016/ . .2015.04.004.

1 4. *American Journal of Science* **274**, 32 355.

& 1 5. ( ). *Geology* **23**, 51 4.

1 . *Structure of Ophiolites and Dynamics of Oceanic Lithosphere.* , 36 .

1 . *Journal of Petrology* **38**, 104 4.

& 200 *a*. *Acta Petrologica Sinica* **25**, 16 24 ( ).

& 200 *b*. *Acta Petrologica Sinica* **25**, 14 4 1 ( ).

& 200 . ^{40} /^{3} *Acta Petrologica Sinica* **23**, 162 34 ( ).

& 2002. 1 6 *Proceedings of the Ocean Drilling Program, Scientific Results, vol. 176* (&), 1 60.

& . 200 . *Chinese Science Bulletin* **14**, 21 6 1.

& . 2010. *Lithos* **117**, 1 20 .

& . 200 . *Journal of Asian Earth Sciences* **30**, 666 5.

200 . *Lithos* **100**, 14 4 .

2014. *Elements* **10**, 101 .

& . 2001. 2. *Contribution to Mineralogy and Petrology* **141**, 36 52.

& . 2013. ( ) *Gondwana Research* **24**, 3 2 411.

& . 1 6. ( ). *Journal of Petrology* **37**, 6 3 26.

& . 2013. *Precambrian Research* **231**, 301 24.

& . 2012. *Precambrian Research* **192 195**, 1 0 20 .

& . 1 1. *Philosophical Transactions of the Royal Society of London* **335**, 3 2.

& . 1 5. *Nature* **377**, 5 5 600.

& . 1 3. *Nature* **364**, 2 30 .

& . 2014. (~440) ( ) *Lithos* **206 207**, 234 51.

2002. *Reviews of Geophysics* **40**, 3-1 3-3 .

& . 200 .

Science in China Series D – Earth Sciences **52**, 1345 5 .

& . 1 *Magmatism in the Ocean Basin* (&), 52 4 . 42.

& . 200 . *Chemical Geology* **247**, 352 3.

& . 200 . *Acta Petrologica Sinica* **23**, 1 33 44 ( ).

& . 1 *Contributions to Mineralogy and Petrology* **133**, 1 11.

& . 2006. *Journal of Geology* **114**, 35 51.

& . 200 . *Lithos* **110**, 35 2.

& . 2012. *Earth-Science Reviews* **113**, 303 41.

& . 1 *Chemical Geology* **20**, 325 43.

& . 2002. *Journal of Geology* **110**, 1 3 .

& . 2006. *Geology in China* **33**, 4 6 6 ( ).

& . 2014. ( ) *Geoscience Frontiers* **5**, 525 36.

& . 200 . *Journal of Asian Earth Sciences* **32**, 102 1 .

& . 2013. *Gondwana Research* **23**, 1316 41.

& . 2004. *Journal of Geological Society, London* **161**, 33 42.

& 200 *a.* *International Journal of Earth Sciences* **98**, 11 21 .

& . 200 *b.* *American Journal of Sciences* **309**, 221 0.

. 1 3. *Regional Geology of the Xinjiang Uygur Autonomous Region*. . 2 145 ( ).

& . 2015. *Journal of Asian Earth Sciences* **113**, 5 .

& . 2012. *Gondwana Research* **21**, 246 65.

& . 200 . *Chemical Geology* **242**, 22 3.

& . 2006. ( ) *Acta Geologica Sinica* **80**, 254 63 ( ).

& . 2003. *Chinese Science Bulletin* **48**, 2231 5.

& . 2013. *Lithos* **179**, 263 4.

& . 2012. *Journal of Asian Earth Sciences* **52**, 11 33.

& . 200 . *Acta Petrologica Sinica* **24**, 1054 5 ( ).

& . 1 6. *Annual Review of Earth and Planetary Sciences* **14**, 4 3 5 1.